Hybrid lightweight X-ray optics for half arcsecond imaging

Completed Technology Project (2016 - 2018)

Project Introduction

This proposal is for the development of grazing incidence optics suitable to meet the 0.5 arcsec imaging and 2.3 square meter effective area requirements of the X-ray Surveyor mission concept, currently under study by NASA. Our approach is to combine two promising technologies, as yet individually unproven at the 0.5 arcsec level, into a hybrid mirror approach. The two technologies are thin piezoelectric film adjustable optics under development at SAO and PSU, and differential deposition under development at NASA MSFC. These technologies are complementary: adjustable optics are best suited to fixing low spatial frequency errors due to piezoelectric cell size limitations, and differential deposition is best suited for fixing mid-spatial frequency errors so as to limit the amount of material that must be deposited. Thus, the combination of the two techniques extends the bandwidth of figure errors that can be corrected beyond what it was for either individual technique. Both technologies will be applied to fabricate Wolter-I mirror segment from single thermally formed glass substrates. This work is directed at mirror segments only (not full shells), as we believe segments are the most appropriate for developing the ~ 3 m diameter X-ray Surveyor high resolution mirror. In this program we will extend differential deposition to segment surfaces (from line profiles), investigate the most realistic error bandwidths for each technology, and determine the impacts of one technology's processing steps on the other to find if there is an optimal order to combining the technologies. In addition, we will also conduct a conical/cylindrical mirror metrology "round-robin," to cross-calibrate the different cylindrical metrology to one another as a means of minimizing systematic errors. Finally, we will examine the balancing and compensating of mirror stress due to the various thin films employed (piezoelectric layer, differential deposition, X-ray reflecting layer(s)) with an eye to minimizing the net stress post-processing such that the residual stress-induced deformations are well within the correction range of the adjustable optic technology. As feasible, hybrid Wolter mirrors will be fabricated and measured via optical metrology (post-round-robin). By looking to develop the combination of these two technologies, while also looking to separately advance each one, this program provides important risk reduction for the key enabling technology of X-ray Surveyor – the mirrors.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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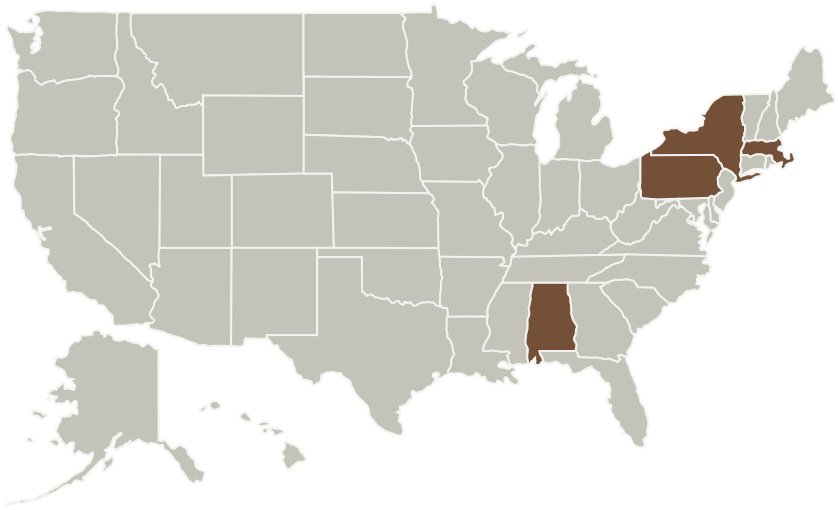
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Smithsonian Institution	Supporting Organization	Industry	Washington, District of Columbia

Primary U.S. Work Locations	
Alabama	Massachusetts
New York	Pennsylvania

Project Management

Program Director:

Mario R Perez

Program Manager:

Mario R Perez

Principal Investigator:

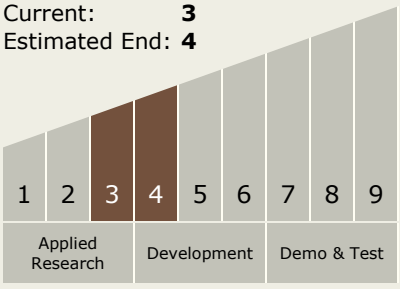
Paul Reid

Co-Investigators:

Alexey Vikhlinin
Susan Trolier-mckinstry
Suzanne E Romaine
Kiranmayee Kilaru
David L Windt
Daniel A Schwartz
Carolyn Atkins
Ryan Allured
Brian D Ramsey
Mikhail V Gubarev
Stephen L O'dell
Christine Mcneil
David M Broadway
David N Burrows
Vincenzo Cotroneo

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



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Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems

Target Destination

Outside the Solar System